Unit 4

Soil Nutrient Management in Vegetable Crops

Introduction

Plant nutrition is an important factor, which directly affects the growth, yield and quality of a crop. Soil contains many mineral nutrients, organic material and water, which are absorbed by plants. If any of these nutrients are deficient or not available in the soil, it affects crop development and a plant shows deficiency symptoms. Therefore, soil nutrient management is necessary for successful crop production. Most of the nutrients are absorbed by plants through their roots from the soil but leaves can also absorb nutrients, if applied in specific formulation as foliar sprays. Nutrients in the soil can be supplemented through the application of fertilisers or manures. Nutrient management includes the type of fertiliser to be applied, rate of application and method of application.

There are a total of 17 nutritive elements, which are necessary for the growth of plants. All elements are equally important irrespective of their requirement or presence in a plant. According to Arnon and Stout (1939), an element must meet the following three criteria:

- a plant cannot complete its life cycle in the absence of that mineral element
- the element is specific and cannot be replaced
- the element must be directly involved in plant metabolism

Session 1: Macro and Micro-nutrients in Soil System

Classification of plant nutrients

Nutrients can be classified according to their requirement and importance in plant life. They can be classified into basic nutrients, macro-nutrients and micro-nutrients. (Fig. 4.1).

Basic nutrients

The basic nutrients are — Carbon (C), Hydrogen (H) and Oxygen (O). These elements are obtained from air and water. Compounds made of these elements are called carbohydrates. Carbohydrates provide strength to cells. Therefore, they are called sources of energy for plants and for organisms who consume plants.

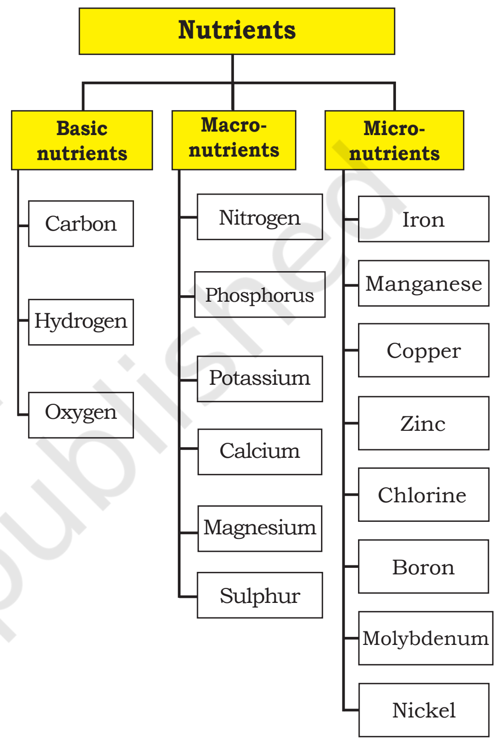

Fig. 4.1: Classification of plant nutrients

Macro-nutrients

This is further divided into:

- *Primary nutrients*: These consist of Nitrogen, Phosphorus and Potassium. These nutrients are supplied through fertilisers.
- *Secondary nutrients*: They include Calcium, Magnesium and Sulphur.

Micro-nutrients

They are also known as minor or trace elements. They include Iron (Fe), Manganese (Mn), Copper (Cu), Zinc (Zn), Chlorine (Cl), Boron (B) Molybdenum (Mo) and Nickel (Ni).

Nutrients, their functions and deficiency symptoms

- *Non-mineral elements*: Carbon (C), Hydrogen (H) and Oxygen (O)
- *Primary nutrients*: Nitrogen (N), Phosphorus (P) and Potassium (K)
- *Secondary nutrients*: Calcium (Ca), Magnesium (Mg and Sulphur (S)

Nitrogen (N)

Functions

(a) promotes the growth of leaves and stems
(b) enhances the dark green colour in plants and improves the quality of foliage
(c) necessary for the development of cell protein and chlorophyll
(d) improves the uptake and assimilation of other nutrients, like phosphorus, potassium, magnesium and sulphur

Deficiency symptoms

(a) loss of vigour and yellowing of green parts
(b) shortening of the stem, leaves become paler and remain small in size
(c) slow growth and a plant becomes dwarf

Phosphorus (P)

Functions

(a) stimulates root formation and healthy growth of roots
(b) vigorous growth and speedy maturity
(c) increases the number of tubers in tuber crops
(d) necessary for enzyme action in many plant processes

Deficiency symptoms

(a) growth of a plant is retarded at the early stage
(b) older leaves curl up and become purplish in colour
(c) sometimes, scorching of leaf margin is observed
(d) slow maturity and vegetative growth continues beyond normal time
(e) delayed tuber formation in tuber crops

Fig. 4.2: Potassium deficiency in cabbage

Potassium (K)

Functions

(a) helps in carbohydrates and protein synthesis
(b) helps in the transfer of carbohydrates from leaves to roots
(c) increases disease resistance, vigour and hardiness to drought and frost

(d) increases yield by increasing the size of tubers, hence, important for processing cultivars

Deficiency symptoms

(a) coincides with the onset of tuber initiation
(b) deficiency symptoms appear as dark bluish green leaves and shortened internodes
(c) terminal leaves show bronzing accompanied by necrotic spots (Fig. 4.2)
(d) in case of acute deficiency, leaf margins dry up and often premature death of a plant occurs

Sulphur (S)

Functions

(a) promotes root growth and vigorous vegetative growth
(b) essential for protein formation
(c) required in metabolic activities

Deficiency symptoms

(a) shoots become light green; veins on the leaves also turn paler
(b) yellowing of leaves and stunted growth of a plant
(c) yellowing starts from upper leaves and the plant shows chlorosis
(d) severe deficiency results in reddening of the stem and curling of leaves inwards
(e) growth of a plant is retarded

Calcium (Ca)

Functions

(a) improves plant vigour
(b) influences the intake and synthesis of other plant nutrients
(c) important constituent of cell wall
(d) increases the yield of large and medium-sized tubers
(e) improves specific gravity of tubers, and thus, enhances tuber quality for processing

Deficiency symptoms

(a) failure of development of terminal buds at apical tips
(b) small leaves

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(c) leaves do not develop normally and have wrinkled appearance
(d) in mild deficiency, a light green band appears along the margin of leaves of terminal buds
(e) in severe deficiency, young leaves at the top remain folded and later their tips die

Magnesium (Mg)

Functions

(a) influences the intake of other essential nutrients
(b) helps in the assimilation of fats
(c) assists in the translocation of phosphorus and fats

Deficiency symptoms

(a) green parts between veins in leaves become pale, though the veins remain green
(b) leaf tips curl up
(c) slender and weak stalks
(d) plants become slightly pale, older leaves develop central necrosis and turn yellow or brown
(e) in severe deficiency, leaflets become thick, brittle, show bulging and roll upwards

Zinc (Zn)

Functions

(a) synthesis of *Tryptophan*
(b) helps in enzyme action
(c) essential for protein synthesis and seed production
(d) fastens the rate of maturity

Deficiency symptoms

(a) younger leaves become yellow
(b) shallow pits develop in the inter-veinal portion on upper surfaces of mature leaves
(c) leaves show inter-veinal necrosis, while midrib remains green
(d) in tomato, small narrow yellow leaves with black spots appear and there is stunted growth in plants

Iron (Fe)

Functions

(a) essential in the enzyme system of plant metabolism

(b) essential for the synthesis of enzymes responsible for chlorophyll synthesis in plants

Deficiency symptoms

(a) yellowing of younger leaf blades, while veins and petioles remain green

(b) affected plants remain small and do not respond well to normal fertiliser treatments

Manganese (Mn)

Functions

(a) helps in the oxidation-reduction process during photosynthesis

(b) essential element in respiration

Deficiency symptoms

(a) plants show a light inter-veinal chlorosis of leaves

(b) mature leaves when observed in light show netted veins

(c) appearance of chlorotic and necrotic spots in inter-veinal areas of leaves

Copper (Cu)

Functions

(a) essential for the synthesis of chlorophyll and other plant pigments

(b) helps improve the flavour and the content of sugar in vegetables

(c) increases the dark green colour of leaves and also the crop yield

Deficiency symptoms

(a) necrosis on the tip of young leaves along the margin

(b) defoliation

(c) leaves of deficient plants curl up and their petioles bend downwards

Molybdenum (Mo)

Functions

(a) involved in nitrogen fixation and nitrate assimilation

(b) required by some microorganisms for nitrogen fixation in soils

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Deficiency symptoms

(a) chlorotic inter-veinal mottling of lower leaves followed by marginal necrosis and infolding of leaves
(b) wilting of leaves
(c) in cauliflower, the lamina of new leaves fails to develop and gives a whiptail appearance

Boron (B)

Functions

(a) helps in the synthesis of the bases of RNA (Ribonucleic acid)
(b) promotes root growth
(c) enhances pollen germination and pollen tube growth, thereby, improving fruiting

Deficiency symptoms

(a) loss of apical dominance
(b) leaf blades develop pronounced crinkling
(c) darkening and crackling of petioles
(d) syrupy exudation from leaf blades
(e) the leaves may have thick coppery texture and sometimes curl up and become brittle

Chlorine (Cl)

Functions

(a) has a direct role in photosynthesis
(b) necessary for shoot apex and root growth

Deficiency symptoms

(a) chlorosis and wilting of young leaves
(b) chlorosis of the inter-veinal area of leaf blade
(c) in severe deficiency, bronzing of the mature leaves on upper surface

What have you learned?

Now, I am able to:

- know about macro and micro-nutrients present in soil.
- understand the functions and deficiency symptoms of nutrients in plants.

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Practical Exercises

Activity 1: Identify deficiency in the given sample of vegetable.
Material required: Sample of vegetables and picture showing symptoms

Procedure

- Observe the sample carefully.
- Identify the crop.
- Identify the symptoms.
- Match with the pictorial chart and confirm it.
- Write down the deficient elements.

Check Your Progress

Fill in the Blanks

1. Compounds made up of carbon, hydrogen and oxygen together are called ________________.
2. Plants obtain carbon, hydrogen and ________________ from air and water.
3. Micro-nutrients are also known as minor or ____________ elements.
4. The function of ________________ is to give dark green colour and improve the quality of foliage.
5. Stimulating root formation and their healthy growth are the functions of ________________.
6. Calcium is an important constituent of the ________________.
7. Magnesium helps in ________________ assimilation.
8. Zinc fastens the rate of ________________ in plants.
9. Manganese is involved in the ________________ process of photosynthesis.
10. Nitrogen fixation and nitrate assimilation are the functions of ________________.

Multiple Choice Questions

1. ________________ essential elements are required for plant growth and development.
   (a) 15 (b) 16
   (c) 17 (d) 18
2. ________________ are the micro-nutrients.
   (a) Ca, Mg, S (b) N, P, K
   (c) C, H, O (d) Zn, Cu, B

3. __________ helps in the synthesis of the bases of RNA.
   (a) Boron (b) Molybdenum
   (c) Chlorine (d) All of the above
4. Molybdenum in plant is necessary for ______________.
   (a) protein synthesis
   (b) photosynthesis
   (c) chlorophyll
   (d) nitrogen fixation
5. Deficiency of boron results in ______________.
   (a) loss of apical dominance
   (b) rosette appearance
   (c) syrupy exudation from the leaf blade
   (d) all of the above

Descriptive Questions

1. What are the criteria of essentiality of nutrients?

   ____

   ____

   ____

2. What are micro and macro-nutrients? Give examples.

   ____

   ____

   ____

3. What are the important functions of nitrogen. Write its deficiency symptoms.

   ____

   ____

   ____

Match the Columns

Nutrients	**Functions/deficiency causes**
1. Phosphorus	(a) Synthesis of the bases of RNA
2. Potassium	(b) Nitrogen fixation and nitrate assimilation
3. Sulphur	(c) Synthesis of chlorophyll
4. Calcium	(d) Assimilation of fats
5. Magnesium	(e) *Tryptophan*
6. Zinc	(f) Failure of terminal bud development
7. Iron	(g) Reddening of stems and inward curling of leaves
8. Molybdenum	(h) Dark bluish green leaves
9. Boron	(i) Curled up and purplish in colour

Session 2: Manures and Fertilisers

A balanced application of nutrients in soil is essential to improve the crop yield and its quality without affecting the soil's health. There are two sources which are most widely used for nutrient management — organic source, generally, called 'manure', and chemical or inorganic source called 'fertiliser'.

Manures

Manures are organic material obtained from animal and plant residues and contain nutrients in the organic form. These organic nutrients decompose slowly, releasing plant nutrients, which can be used as organic nutrients in agriculture. Manures can be classified into Farm Yard Manure (FYM), compost, green manure, which contains less amount of nutrients and is applied in bulk, and concentrated manures (oil cakes, blood meal, meat meal, fish meal, horn and hoof meal, raw bone meal and steamed bone meal, which have high nutrient content and supply nitrogen for a longer period). The nutrients supplied by manures are given in Table 4.1.

Advantages

(a) They improve the soil structure and increase its water holding capacity.
(b) Manures add organic matter to the soil and stimulate the activity of soil microorganisms.
(c) There is no risk of forming toxic build-up as observed due to the use of chemicals.
(d) Leguminous crops (peas and beans) when used as green manure add nitrogen to the soil.
(e) Manures are renewable, biodegradable and eco-friendly.

Disadvantages

(a) Manures are slow in action.
(b) These require moisture for decomposition and release of nutrients.
(c) The cost of green manure may be more than the cost of commercial fertilisers.

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(d) There can be favourable conditions for pests if undecomposed organic manures are used.
(e) Nutrient ratio to the weight of the manure is less, so it is required in large quantities.

Common manures

Farm Yard Manure (FYM)


Fig. 4.3: Farm Yard Manure

FYM is a decomposed mixture of dung and urine of farm animals, along with litter and leftover material from fodder or roughages fed to animals (Fig. 4.3). It takes 4–6 months for complete decomposition. On an average, decomposed FYM contains 0.5% N, 0.2% P and 0.5% K. Phosphorus and potash are available in the soil in the form of oxides (P_2O_5 and K_2O). It is the most commonly used organic manure in vegetable crops. It is applied at the time of first ploughing during field preparation.

Compost


Fig. 4.4: Compost

Compost is an organic manure produced by the decomposition of organic wastes (Fig. 4.4). It is made of cattle wastes, urine soaked earth, cow dung, leaves and branches of plants, and is ready for use within four months. Compost improves the soil structure and stimulates beneficial micro-organisms.

Oil cakes


Fig. 4.5: Groundnut cake

These are coarse residues obtained after oil is removed from oilseeds. These are applied to the soil at the time of land preparation and can be used along with fertilisers. These cakes add nutrients to the soil, as well as, improve the soil structure. Oil cakes are of two types— edible and non-edible.

Edible oil cakes

These are obtained after the extraction of edible oil. These can be fed to the cattle. Groundnut cake (Fig. 4.5), linseed cake, rapeseed (*Brassica napus*) cake, cotton seed cake, safflower cake, sesame cake, etc., are examples of edible oil cakes.

Non-edible oil cakes

These are mostly used for horticultural crops. These cakes are obtained after the extraction of oil, which is not edible. *Karanja* (*Pongamia* species) cake, neem (*Margosa*) cake and *mahua* (*Madhuca* species) cake, etc., are examples of non-edible oil cakes.

Table 4.1: Nutrients supplied by manures (%)

S. No.	Manure	N (%)	P_2O_5 (%)	K_2O (%)
1	**Manures of plant origin**			
	(a) Cotton seed cake	3.9–4.0	1.8–1.9	1.6–1.7
	(b) Green manure (avg.)	10.0–12.0	1.0–1.5	0.6–0.8
	(c) Groundnut cake	7.0–7.2	1.5–1.6	1.3–1.4
	(d) *Karanja* cake	3.9–4.0	0.9–1.0	1.3–1.4
	(e) Linseed cake	5.5–5.6	1.4–1.5	1.2–1.3
	(f) Neem cake	5.2–5.3	1.0–1.1	1.4–1.5
	(g) Rapeseed cake	5.1–5.2	1.8-1.9	1.1–1.2
	Wood ashes			
	(a) Ash babul	0.1–0.2	2.5–3.0	3.5–4.5
	(b) Ash coal	0.73	0.45	0.53
	Plant residue			
	(a) Groundnut husk	1.6–1.8	0.3–0.5	1.3–1.7
2	**Manures of animal origin**			
	(a) Bird guano	0.4–0.8	0.3–0.6	0.7–1.0
	(b) Bone meal	0.1–0.7	0.1–0.2	0.8–1.6
	(c) Cattle dung and urine mixed	5.2–5.3	1.0–1.1	1.4–1.5
	(d) Dried blood	0.5–1.5	0.4–0.8	0.5–1.9
	(e) Fish manure	1.2–2.0	1.0	1.5
	(f) Night soil	3.9–4.0	0.9–1.0	1.3–1.4
	(g) Settled sludge (dry)	3.9–4.0	1.8–1.9	1.6–1.7
3	**Composite manures**			
	(a) Compost (Rural)	0.4–0.8	0.3–0.6	0.7–1.0
	(b) Compost (Urban)	1.0–2.0	10–1.2	1.2– 1.5
	(c) Farm Yard Manure (FYM)	0.5–0.7	0.4–0.8	0.5–1.9

Green manure

Green manuring is a practice, wherein crops, like sunn hemp (*Crotalaria juncea*), *dhaincha* (*Sesbania aculeata*), pillipesara (*Phaseolu strilobus*) and cluster bean (*Cyamopsis te tragonoloba*) are grown and the entire crop is then turned down in the soil for improving its fertility. Green manures can be applied in two ways. They are:

Fig. 4.6: Green manure crop (sunn hemp)

Prior to the main crop

Specific green manure crop is raised in the field and at flowering, it is ploughed or turned into the soil. The crop on decomposition improves the physical structure and fertility of the soil. The green manure crop is grown in the field 1–2 months prior to the desired crop. Green manure crop can be cultivated during the *Kharif* season and incorporated for the benefit of *Rabi* crop.

Cultivated after main crop

In some areas, the green manure crop is cultivated after the main crop for the benefit of the succeeding crop. Here, the tender green twigs and leaves of the green manure plants are spread in the field and mixed into the soil at the time of land preparation. This is a common practice in Eastern and Central India.

Vermicompost

The organism, which plays the most important role in the fertility of the soil, is earthworm. Due to its merits, it is called a 'pudding of nature'. Vermicompost is prepared by the decomposition of organic plant material by earthworms (Fig. 4.7). Earthworms release faecal matter called 'vermicasting'. FYM, kitchen waste, plant litter and other kinds of biodegradable wastes are spread on the vermicast, which is kept moist by frequent watering. Under suitable environment, the earthworms consume the organic matter and turn it into vermicompost. It is estimated that one million worms present in one acre area will produce vermicompost of about 500 kg/day. Vegetable crops require 1.5–3 tonnes/ha vermicompost and it can be applied at any stage of crop growth. It can be mixed with the soil, and then, broadcasted.

Fig. 4.7: Vermicompost

Advantages

(a) It can be used for all vegetable crops at any stage of crop growth.
(b) It is rich in all essential plant nutrients and improves plant growth, yield and quality of produce.
(c) It is easy to handle, store and does not emit an odour.

(d) It contains certain microorganisms, which help in nitrogen fixation and phosphorus solubilisation.
(e) It minimises the incidence of pests and diseases in vegetable crops.
(f) The percentage of nitrogen, phosphorus and potassium is more in vermicompost as compared to other compost.
(g) It improves the soil texture, structure, its water holding capacity, aeration and checks soil erosion.

Application of manures

Manures, such as oil cakes and FYM, should be applied or ploughed into the soil 15–20 days before sowing and transplanting due to the slow release of nutrients from manures. The crop growth is affected if undecomposed or fresh manure is used for cultivation. Therefore, it is advisable to use fully decomposed manure. When fresh FYM is used, it causes burning effect due to the presence of excess soluble nitrogen. An applicable dose of about 20–25 tonnes/ha is recommended for the cultivation of vegetable crops.

Bio-fertilisers

Bio-fertilisers are carrier-based preparation, containing beneficial microorganisms, such as bacteria, fungi and algae in sufficient quantities, helping plant growth and nutrition. They decompose the complex organic matter and make them easily available to plants. The nitrogen present in the atmosphere is transferred to the soil by bacteria, which further helps boost plant growth. Bio-fertiliser includes microorganisms, which add, conserve and stimulate plant nutrients in the soil. Thus, their activities are helpful in increasing the soil's fertility. Bio-fertilisers should never be mixed with insecticide, fungicide, herbicide and fertilisers.

Classification of bio-fertilisers

Bio-fertilisers can be broadly divided into two groups:
(a) *Nitrogen fixing bio-fertilisers*: These can fix the atmospheric nitrogen, e.g., *Rhizobium*, *Cyano-bacteria* or *BGA, Azotobacter* and *Azospirillum*.

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b) *Phosphate mobilising bio-fertilisers*: These can solubilise or mobilise phosphate in the soil, e.g., bacteria, like *Bacillus* and *Pseudomonas*, and fungi, like *Aspergillus* and *Penicillium*.

Types of bio-fertilisers

Fig. 4.8: Rhizobium nodules in cowpea

Rhizobium

These bacteria fix nitrogen in the roots of leguminous crops. They colonise in roots of specific leguminous plants to form a tumour-like structure called 'root nodules' (Fig. 4.8). These nodules fix the atmospheric nitrogen symbiotically. *Rhizobium*–legume association can fix up to 100–300 kg of N per ha/year.

Azospirillum

Besides fixing nitrogen, these bacteria also increase mineral and water uptake in plants. This nutrient in crop plants leads to improved root development and vegetative growth. *Azospirillum* can fix 25–30 kg N/ha. This results in 15–30% increase in the crop yield. It is recommended for onion and co-inoculants for legumes.

Azotobacter

It is non-symbiotic bacteria that fixes nitrogen and produces growth promoting substances, like vitamin B group, indole Acetic acid and Gibberellic acid. *Azotobacter* fixes nitrogen 20–30 kg/ha from the atmosphere. This bio-fertilser is recommended for different vegetable crops, like potato, onion, brinjal, tomato, chilli, cabbage, cauliflower and okra. Apart from nitrogen, this organism is also capable of producing anti-fungal and anti-bacterial compounds.

Fig. 4.9: Azolla

Azolla

These are symbiotic in nature, suitable only for flooded rice and fix nitrogen symbiotically with *Anabaena azollae*. These contain chlorophyll and get energy from photosynthesis to fix atmospheric nitrogen (Fig. 4.9). These can fix 100–150 kg N per ha/year with about 40–60 tonnes of biomass.

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Blue Green Algae (BGA)

BGA is also known as '*Cyanobacteria*'. These are phosphoric in nature and produce auxin, indole Acetic acid and Gibberellic acid. Nitrogen fixation in flooded rice fields is done by BGA.

Phosphorus Solubilising Bio-fertilisers (PSBF)

These microorganisms can convert insoluble soil phosphate into soluble forms by secreting several organic acids. These are found effective in increasing soluble phosphorus in a soil by 10–20 per cent. It is recommended for all crops. These microorganisms are mainly bacteria and fungi. The include bacteria, like *Bacillus* and *Pseudomonas,* and fungi, like *Aspergillus* and *Penicillium*.

Vesicular Arbuscular Mycorrhiza (VAM)

VAM enhances the uptake of phosphorus, zinc, sulphur and water, leading to increased yield and uniform crops growth. VAM builds resistance against root diseases and improves the hardness of the transplant stock. It is recommended for maize, millets, sorghum, barley and leguminous crops.

Application of bio-fertilisers

Seed treatment

For treating seeds, a solution is prepared by adding 100 g of inoculants (culture of microbes) in 200 ml of water. The seeds are then dipped in the solution.

Seedling root dip

The method of seedling root dip is used in crops that require transplanting. Inoculants measuring 400 g is mixed in 20 litres of water to prepare a suspension slurry (solutions). Seedling roots are dipped in the suspension slurry for 15–30 minutes.

Tuber dip treatment of potatoes

A suspension is prepared by adding 1 kg inoculants in 40–50 litres of water. The tubers are immersed in the suspension for 5–10 minutes and planted immediately.

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Soil treatment

Inoculant measuring 5–7 kg is mixed in about 50–100 kg rotten FYM or soil and applied in one hectare land.

In case of direct sowing of seeds, *Rhizobium* is applied for all legumes as inoculants, whereas, *Azospirillum*/ *Azotobacter* is inoculated through seeds, seedling root dip, direct sown crops and soil treatment.

Fertilisers

Fertilisers are artificially made of chemicals, which supply essential nutrients to plants. They are available in concentrated forms and contain higher amount of nutrients than manure, and are, therefore, used in small quantities. There are three kinds of fertilisers used for vegetable crops *viz*., nitrogenous, phosphatic and potassium. Fertilisers can also be classified into straight, compound and mixed.

Advantages

Fertilisers are readily available nutrients to plants. The exact amount of a given element can be calculated and applied to plants. Some of their advantages are:

(a) Fertilisers are easy to carry as they are packed in 50 kg plastic bags.

(b) They can be easily applied in different ways.

(c) Fertilisers are easily available in different formulations and concentrations.

Disadvantages

(a) A fertiliser costs much higher than organic fertilisers, if used in bulk.

(b) The nutrients can easily be leached or washed away in rainwater or irrigation water.

(c) It is harmful if applied more than the required dosage.

(d) It decomposes fast and has to be applied frequently.

(e) It contains certain compounds and salts, which are not absorbed by plants, and therefore, has an adverse effect on soil properties.

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(f) Chemicals and their reactions prove harmful to biological activities of the soil.

Type of fertilisers

Sole fertiliser or straight fertilisers

These fertilisers have only one chemical compound or supply only a single nutrient. It is sometimes accompanied by a minor element. Sole fertilisers are further grouped according to the nutrient they supply. The nutrient content of different fertilisers are shown in Table 4.2.

Nitrogenous fertilisers

These are prepared and applied as a source of nitrogen to the crop. These are decomposed fast and applied in split doses at the time of sowing and the rest as top dressing during flowering and fruit set. Commonly available nitrogenous fertilisers are — urea, calcium, Ammonium nitrate and Ammonium sulphate.

Phosphorus or phosphatic fertilisers

Phosphatic fertilisers are expressed in terms of the percentage of Phosphorus pentoxide (P_2O_5). They are the main source of phosphorus. The mobility of phosphorus is very slow. It is used as a basal application during land preparation. Some commercially available phosphatic fertilisers are — Single super phosphate, Double super phosphate, Triple super phosphate, Dicalcium phosphate, etc.

Potassium fertilisers

These fertilisers are applied as a source of potassium to plants and expressed as K_2O. These are applied before sowing or during seed sowing. Commonly used potash fertilisers are Potassium chloride or muriate of potash, Potassium sulphate, etc.

Mixed fertilisers

Fertilisers supplying more than one macro-nutrient to plants are known as mixed fertilisers. These are mixtures of nitrogen, phosphorus and potash (N, P and K) in various suitable proportions. Commonly used

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mixed fertilisers are Nitrogen phosphate with potash (15:15:15), NPK (10:26:26) and NPK (12:32:16).

Compound fertilisers

These fertilisers supply more than one plant nutrient, usually two, such as nitrogen and Phosphoric acid or nitrogen and potassium. The commonly used compound fertilisers are — Diammonium phosphate (18:46:0), Ammonium phosphate sulphate (16:20:0), Mono-ammonium phosphate (11:52:0), etc.

Table 4.2: Approximate nutrient content in different fertilisers

Fertiliser	N (%)	P_2O_5 (%)	K_2O (%)	Others (%)
Nitrogenous				
Ammonium chloride	25.0	–	–	–
Ammonium sulphate	20.5	–	–	–
Anhydrous ammonia	82.2	–	–	–
Calcium ammonium nitrate	25.0	–	–	–
Urea	46.0	–	–	–
Phosphatic				
Ammonium phosphate	20.0	20.0	–	–
Diammonium phosphate (DAP)	16	46	–	–
Double super phosphate	–	32.0	–	–
Rock phosphate	–	20.0–40.0	–	–
Single super phosphate	–	16.0	–	12% (S)
Triple super phosphate	–	46.0	–	
Potassium				
Muriate of potash (MOP)	–	–	60	-
Potassium magnesium sulphate	–	–	22.0	11.0 (Mg) 18.0 (S)
Potassium nitrate	13.8	–	44.0	–
Potassium polyphosphate	–	56.0	24.0	–
Sulphate of potash	–	–	50	17% (S)

Micro-nutrient fertilisers

Micro-nutrients are required by plants in small quantities. Chemical compounds, which are used as sources of micro-nutrients and applied to plants, are called micro-nutrient fertilisers. Zinc sulphate ($ZnSo_4$),

Copper sulphate ($CuSo_4$), Ferrous sulphate ($FeSo_4$), Manganese sulphate ($MnSo_4$), etc., are commonly used micro-nutrient fertilisers. All are soluble in water and can be used as soil application or foliar spray.

Methods of fertiliser application

Soils react differently with the application of fertilisers. Similarly, the requirement of nitrogen, phosphorus and potash vary from crop-to-crop. The requirement of these nutrients is not the same at different stages of growth or in different types of soil. In general, full amount of phosphorus and potash and half amount of nitrogen are applied during land preparation as basal dose, and the remaining half nitrogen is top-dressed in 2–3 split doses (Table 4.3, see page 85).

Basal application

This method refers to the application of fertilisers into soil before or at the time of planting. There are several methods of basal application, which are listed as follows:

(a) broadcasting of nitrogen, phosphorus and potassium fertilisers in large quantities on the surface before ploughing (Fig. 4.10)

(b) placement of fertilisers in a continuous band at the bottom of a furrow opened during ploughing

Fig. 4.10: Fertiliser broadcasting

(c) fertilisers are applied in bands 2–3 inches or more away from the row and 2–3 inches or more below the surface

(d) combination of broadcasting or plough furrow placement with band placement at the side of the row at sowing and transplanting

(e) the fertilisers are applied with a drill below the surface of the soil before sowing or during seed sowing with a seed-cum-fertiliser drill

Top dressing

The fertiliser is applied in the standing crop in case of top dressing. There are several methods of top dressing.

(a) broadcasting fertilisers in moist fields 2–5 days after irrigation

(b) applying fertilisers around individual plants
(c) applying fertilisers along rows

Fig. 4.11: Foliar application of fertiliser

Foliar application

Macro-nutrient fertiliser can also be applied through foliar spray (Fig. 4.11). The nutrients enter the leaves through the stomata, correct certain disorders, and improve the yield and quality of the produce. Among the macro-nutrients, urea (0.5–1.5%) is highly suitable for foliar application because of its high solubility, ease and quick absorption by plant tissues.

Methods of micro-nutrient application

There are four ways of applying micro-nutrients.

Soil application

Micro-nutrient along with fertilisers can be applied to the soil for desirable plant growth and yield. The recommended dose of micro-nutrient for soil application is 0.5–10 kg/ha for iron, 5–12 kg/ha manganese, 0.5–8 kg/ha for zinc, 0.5–5 kg/ha for boron and 0.05–1 kg/ha for molybdenum.

Seedling root dipping

Seedlings are dipped in a prepared solution before transplanting. Generally, 0.2–0.3% solution of Zinc sulphate is used for root dipping.

Seed treatment

The seeds are sown after they are treated with chemical compounds of Cu, Fe, Mo, Zn, B and Mn, etc.

Foliar spray

Foliar application of micro-nutrients are widely used as they are convenient to apply, required in small quantities, do not get fixed in the soil and help correct deficiency or disorders.

Individual vegetables require specific doses of various nutrients in the form of nitrogen, phosphorus and potash (NPK). The recommended dose of the NPK is shown in Table 4.3.

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Table 4.3: Recommended dose of NPK for vegetable crops

Vegetable crops	N (kg/ha)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Beans	60–120	50–80	50–80
Brinjal	100–200	60–80	50–100
Cabbage	100–200	80–100	50–100
Carrot	80–150	60–80	80–100
Cauliflower	100–200	60–80	50–100
Chilli	100–300	80–100	80–100
Cowpea	50–100	40–60	40–60
Cucumber	80–150	40–60	40–70
Garden pea	60–80	50–60	50–60
Garlic	100–200	60–80	60–80
Lettuce	120–180	40–80	50–80
Okra	100–150	50–80	50–80
Onion	120–300	60–80	50–80
Spinach	80–120	40–60	40–60
Potato	100–200	60–80	80–120
Snap bean	100–150	50–80	50–80
Tomato	100–200	60–80	50–100
Watermelon	100–160	40–60	60–80

What have you learned?

Now, I am able to:

- distinguish between different types of manures and their methods of application.
- distinguish between different types of fertilisers and their methods of application.
- know NPK dosage for different vegetable crops.

Practical Exercises

Activity 1: Identify various fertilisers.

Material required: Fertiliser samples, water, container, litmus paper (both red and blue), etc.

Procedure

- Collect fertiliser samples in a small polybag.
- Record the following observations.

Notes

NOTES

Characteristics of fertilisers

Names of fertilisers	Hygroscopicity	Colour	Granules or powder	Solubility in water	Reaction on litmus paper
Nitrogenous					
(a)					
(b)					
(c)					
Phosphatic					
(a)					
(b)					
(c)					
Potassic					
(a)					
(b)					
(c)					

Activity 2: Identify different types of manures.

Material required: Manure of different types, dish

Procedure

- In a dish, keep a manure for identification.
- Write down its name.
- Write the class of the manure.
- Write the percentage of nutrients present in it.

S. No.	Name of manure	Class/source
1.	FYM	Decomposed organic waste of plants and animals
2.	Compost	Decomposed organic waste of plants and animals
3.	Cotton cake	Edible oil cake
4.	Branch of glyricidia	Green manure
5.	Vermicompost	Earthworm

Activity 3: Compost making using waste material in school

Material required: Pick axe, spade, measuring tape, baskets, stick or bamboo, other waste material

Procedure

- Dig a pit of 2 × 2 × 0.8 m size at a selected site in a school. Make its bottom complete or partial *pucca*.
- Collect organic waste material daily. Deposit it in the pit in layers of 20–25 cm.
- When 2 or 3 such layers are deposited in the pit, spread cow dung slurry (1:10 ratio) and spread soil over them in a thick layer of 2–2.5 cm. Continue in the same way till the pit is filled.
- Add water to the pit to maintain enough moisture for the decomposition of the waste material.
- Cover the pit with soil and cow dung again.
- After one month, remove a small portion of the soil to check the moisture content.
- Check again after three months. The compost is ready for use.

Observations

The students need to observe the compost for following properties and determine the quality of the compost prepared.

Properties	Undecomposed	Decomposed
(i) Odour		
(ii) Texture		
(iii) Colour		
(iv) Pliability		

Check Your Progress

Fill in the Blanks

1. The ______________ can be applied at any stage of crop growth.
2. For applying fertilisers into the soil before or at the time of planting, ______________ method is used.
3. Urea is highly suitable for ______________ application because of its high solubility, ease and quick absorption.
4. FYM contains ________ % N, ________ % P_2O_5, and ________ % K_2O_5.
5. For root dipping, ___________________% Zinc sulphate solution is used.
6. The ______________ fixes nitrogen symbiotically with leguminous crop.

Notes

NOTES

Multiple Choice Questions

1. Which is a non-edible oil cake?
   (a) Groundnut cake
   (b) Cotton seed cake
   (c) Neem cake
   (d) Linseed cake
2. Which of the following is a compound fertiliser?
   (a) Calcium ammonium nitrate
   (b) Double super phosphate
   (c) Nitro phosphate with potash
   (d) Diammonium phosphate
3. Identify the crop which is used as whole for green manuring.
   (a) *Glyricidia* (b) *Sesbania*
   (c) *Dhaincha* (d) *Karanja*
4. Organic manures should be best applied ____________.
   (a) 15–20 days before transplanting
   (b) at the time of transplanting
   (c) 15–20 days after transplanting
   (d) all of the above
5. Recommended NPK dose per hectare for tomato is __________.
   (a) 100–200; 60–80; 50–100
   (b) 50–100; 100–150; 60–80
   (c) 60–80; 100–200; 50–100
   (d) 70; 90; 100–200
6. Vermicompost is applied in vegetables at the rate of __________.
   (a) 2–3 tonnes/ha
   (b) 5–6 tonnes/ha
   (c) 10–12 tonnes/ha
   (d) 20–22 tonnes/ha
7. Manures are organic nutrients in complex form derived from __________.
   (a) Animals (b) humans
   (c) plant residues (d) all of the above
8. Which of the following is a bulky manure?
   (a) FYM (b) Compost
   (c) Green manure (d) All of the above

Descriptive Questions

1. Write down the advantages of organic manure.

   ____
   ____
   ____

2. Write a brief note on vermicompost and its application.

3. What is a green manure crop? What are its advantages and disadvantages?

4. What are the different methods for the application of fertilisers in vegetable crops?

Match the Columns

Column A	Column B
1. Basic nutrients	(a) Secondary nutrients
2. Ca, Mg, S	(b) Urea, DAP and MOP
3. Hollow heart of legumes	(c) Faecal matter of earthworms
4. Tuberisation	(d) Nitrogenous fertilisers
5. Bulky organic manures	(e) Boron
6. Vermicasting	(f) FYM and Compost
7. Chemical fertilisers	(g) Potassium
8. Split application	(h) C,H,O

Notes